

MAPP Program FY 2015 Information Sheet

Program Overview and Goal

The mission of the Modeling, Analysis, Predictions, and Projections (MAPP) Program¹ is to enhance the Nation's capability to predict variability and change in Earth's climate system. The MAPP Program focuses on the coupling, integration, and application of Earth System models and analyses across NOAA, among partner agencies, and with the external research community. Primary objectives include 1) improving Earth System models, 2) supporting an integrated Earth System analysis capability, 3) improving methodologies for global to regional-scale analysis, predictions, and projections, and 4) developing integrated assessment and prediction capabilities relevant to decision makers based on climate analyses, predictions, and projections.

FY 2015 Competitions

In FY 2015, the MAPP Program is soliciting proposals for the following three competitions:

- Process-oriented evaluation of climate and Earth system models and derived projections
- North American Multi-Model Ensemble system evaluation and application
- Advancing a common software modeling and data infrastructure for NOAA's global models

Individual proposals may target only one competition which must be clearly identified in the proposal summary. Details regarding the three MAPP Program FY 2015 competitions are given below.

Competition: Process-oriented evaluation of climate and Earth system models and derived projections

Evaluation of climate and Earth system model output is a critical step in the model development process and also integral for generating a better understanding of model biases in an applied context. For instance, community evaluation of models that contributed to the Coupled Model Intercomparison Project, Phase 5 (CMIP5) is guiding ongoing development of next-generation models. Similarly, there is the need to assess confidence in CMIP5-based climate projections, considering the impact of model biases, as these will be used by climate assessments, including the next National Climate Assessment (NCA)².

In this context, there is a growing community interest in moving beyond performance-oriented metrics toward process-oriented diagnostics both for accelerating model development and to fill the information gap in confidence assessment of model projections^{3,4}. Such diagnostics examine key model areas, enabling evaluation of model performance in simulating critical phenomena or variables against aspects of the model's underpinning physical or chemical processes. The World Climate Research Program WGNE/WGCM Climate Model Metrics Panel has discussed process-oriented metrics as a next step for model diagnostics work toward improving model performance; as an example, the YOTC MJO Task Force⁵ has developed process-oriented diagnostics for improving model simulation of the Madden Julian Oscillation. Similarly, the MAPP CMIP5 Task Force⁶ has begun exploring the development and application of CMIP5-based process-oriented diagnostics in

¹ <http://cpo.noaa.gov/ClimatePrograms/ModelingAnalysisPredictionsandProjections.aspx>

² The third NCA is available here: <http://nca2014.globalchange.gov/>

³ National Research Council, 2012. A National Strategy for Advancing Climate Modeling. Washington, DC. National Academy Press. http://www.nap.edu/catalog.php?record_id=13430

⁴ <http://www-metrics-panel.llnl.gov/wiki/moreinfo>

⁵ <http://yotc.ucar.edu/mjo/mjo-wg-heritage>

⁶ www.cpo.noaa.gov/MAPP/CMIP5TF

support of both model development activities and the assessment of the confidence in model projections for the NCA⁷.

Given this community direction, ongoing efforts to develop next-generation climate and Earth system models, evolving plans for the next phase of CMIP, and a growing interest in the applications community particularly for assessments such as the NCA, the MAPP program is soliciting proposals for research in FY 2015 for the process-oriented evaluation of climate and Earth system models and derived projections. Research will focus on two areas:

- A. *Metrics for climate and Earth system model development*
- B. *Metrics for the evaluation of model projections in support of the National Climate Assessment*

Research proposals are sought that address some or all of the aspects in focus areas A or B. If feasible, proposed work in focus area A may be scoped such that it also informs elements of focus area B and vice-versa.

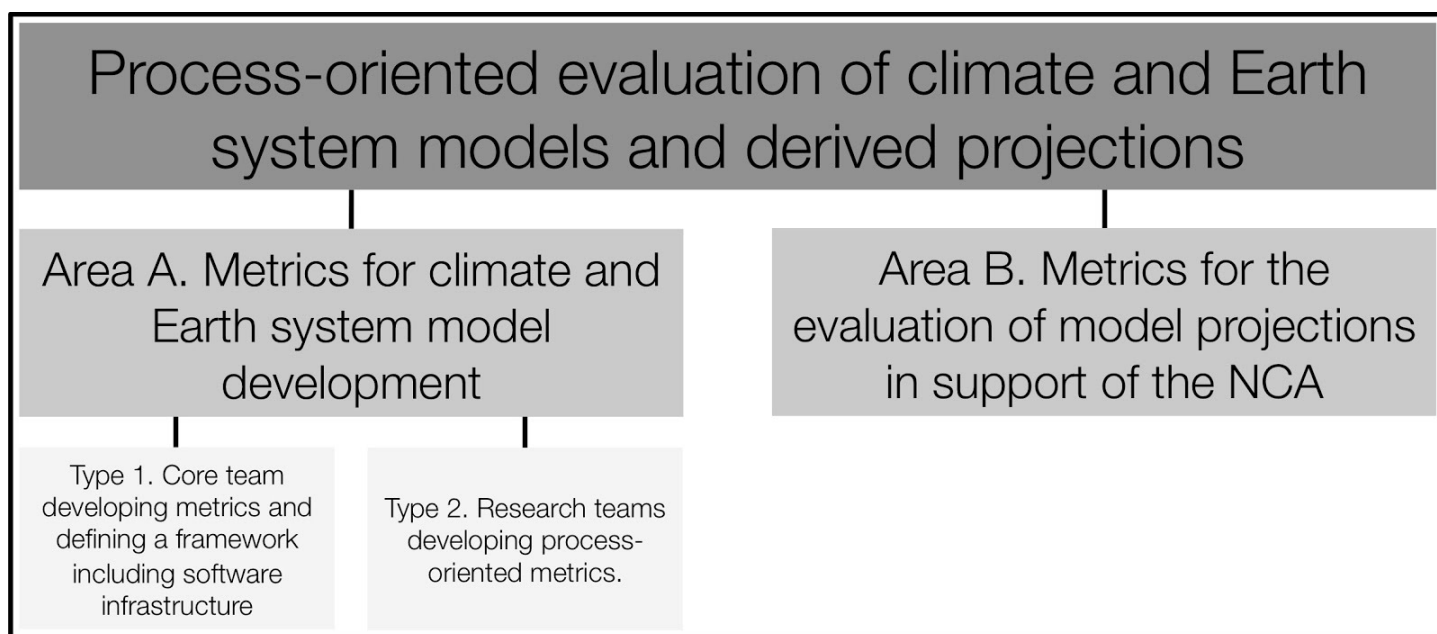


Figure (above): Structure of process-oriented metrics competition.

Area A. Metrics for climate and Earth system model development

Research projects should propose to develop and apply process-oriented metrics to evaluate simulated climate phenomena with strong theoretical and observational bases that are represented by climate and Earth system models at resolutions typical of contemporary global models. Data from CMIP5 as well as other relevant multi-model datasets should be used. Diagnosis should focus on phenomenological behavior that relates a metric of model performance to a metric describing a key underpinning climate process where such relationships have solid theoretical support in the literature. Metrics should focus on elements of the climate mean state, variability patterns, or trend and provide a clear framework for evaluating processes associated with those climatic phenomena and their simulation by models with the intent to guide model development.

⁷ http://cpo.noaa.gov/sites/cpo/MAPP/pdf/CMIP5TF_Process_Oriented_Metrics_Whitepaper.pdf

Research should focus on developing and delivering process-oriented metrics for the advancement of climate and Earth system model diagnostic and development efforts with a focus on NOAA models. Proposals that demonstrate collaborations and synergies with similar efforts at other leading U.S. modeling centers are strongly encouraged. Proposals should utilize multiple model outputs from the CMIP5 data set for robust multi-model statistics and general applicability of metrics across models. Proposals should demonstrate that appropriate variables are available with the necessary temporal and spatial resolution for multiple models to perform a robust multi-model process-oriented analysis. Research work should aim toward the incorporation of the newly developed diagnostics into modeling centers' diagnostic packages, such that these can be utilized across model generations and centers, for example in the context of the next CMIP.

Two different types of proposals may be submitted in response to Area A of this solicitation:

- **Type 1:** Proposals by a core team which addresses the research objectives described above and defines a direction and framework for the development and inclusion of the new process-oriented metrics in model development efforts and diagnostic packages. Proposals should include the development of the necessary software infrastructure giving particular consideration to a multi-institutional approach to metrics and model evaluation. The team should leverage and build upon existing investments at NOAA laboratories and operational centers as well as non-NOAA modeling centers. Proposals should maximize portability of any diagnostics developed and utilize this funding opportunity to extend NOAA's internal efforts. Leveraging and coordination with other relevant efforts is encouraged⁸.

- **Type 2:** Proposals will address the research objectives described above focusing on the development of process-oriented metrics for model analysis and diagnosis with outcomes relevant to the evaluation of climate and Earth system models. Type 2 proposals will focus on the development of metrics as opposed to also considering software infrastructure issues related to the inclusion of the new metrics in the diagnostics packages. Software issues will be centrally handled by the Type 1 project team in coordination with Type 2 projects.

Type-1 proposals will need to include a workplan for the entrainment of metrics produced by their team and Type-2 projects such that research projects from this solicitation deliver useable diagnostics to inform model development as part of modeling centers diagnostic packages. In this regard, collaboration with NOAA modeling centers and relevance to their model development plans is encouraged.

It is envisioned that only one Type-1 proposal will be funded as a result of this solicitation (up to \$400k per year). Multiple Type-2 awards may be made (typical size is \$75K to \$150k per year). For all awards, the duration is up to three years. The Type-1 award may be administered as a Cooperative Agreement to facilitate collaborative work including coordination with Type-2 projects.

Points of contact for this solicitation at NOAA laboratories and centers are Brian Gross (brian.gross@noaa.gov) and Hendrik Tolman (hendrik.tolman@noaa.gov).

Area B. Metrics for the evaluation of model projections in support of the National Climate Assessment

⁸ Examples include the UV-CDAT and EMBRACE EsmVal-Tool efforts.

Research will be driven by the need to evaluate regional climatic features and projected changes key to the NCA and recipient decision makers. Research will use CMIP5 multi-model data to develop and apply process-oriented metrics that link regional climate phenomena or climate variables of interest for the NCA with the underpinning regionally-relevant physical processes in the models. Proposed metrics will enable process-level diagnosis of model performance at regional scales over North America to inform confidence in derived climate model projections in view of model biases. Such process-based metrics may be applicable to both global CMIP5 projections and derived regional climate model experiments, hence providing means for process-level intercomparison. Projects should consider the applicability of the process-based metrics for the assessment of confidence in CMIP5 model projections and their refinement based on the regional assessment of process-level model performance.

Research should focus on North American climate features with a link to the NCA. Teams should include expertise with process-level understanding of climate models and the use of CMIP5 model data; regional-scale understanding of physical climate variability and change; and needs for and use of climate model data and projections in the NCA context. Key elements of successful proposals will be a feasible collaboration between the physical climate, model analysis, and regional assessments communities. Research teams should incorporate understanding of stakeholder and applied needs through collaborations with investigators who have been involved in the third National Climate Assessment and are also involved in preparations for the next NCA.

In this regard, collaboration with investigators from Regional Integrated Sciences and Assessments⁹ (RISA) Teams is encouraged. Proposals may focus on one or more key climate features of interest for which process-oriented evaluation frameworks will be developed and applied. Proposers should expect to engage with the development process for the next NCA in order to communicate their findings, and as such should specify how to communicate the evaluation findings in a format relevant to the NCA.

The duration of proposed research projects is up to 3 years and up to \$150k per year.

In both research Areas, proposers are encouraged to benchmark model process-oriented diagnostics against observations collected as part of the Obs4MIPs effort¹⁰ as well as any other relevant observations. Awards resulting from this competition are expected to constitute elements of a new MAPP CMIP5 Task Force initiated in 2015, which will aim to facilitate coordination and synergies among the various funded projects.

Competition Contact Information:

MAPP Program Manager Competition Manager: Dan Barrie (daniel.barrie@noaa.gov)

RISA Contact: Adam Parris (adam.parris@noaa.gov)

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Competition: North American Multi-Model Ensemble system evaluation and application

Societal challenges, such as the occurrence of climate extremes and other high impact climate variability, require an improved predictive capability. The National Research Council's (NRC) 2010 report "Assessment of Intraseasonal to Interannual Climate Prediction and Predictability"¹¹ recommended experimentation with

⁹ <http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram.aspx>

¹⁰ <https://www.earthsystemcog.org/projects/obs4mips/>

¹¹ National Research Council, 2010 Assessment of Intraseasonal to Interannual Climate Prediction and Predictability

multi-model ensembles as a way to improve upon current predictive capabilities, as research has shown that multi-model systems have prediction skill that is generally superior to that of any single-model system. Consistent with the recommendation from this NRC report, a multi-model prediction system named the North American Multi-Model Ensemble (NMME)¹² system has been run experimentally with specific forecast completion deadlines, reliability, and variables similar to operational prediction schedules with the aim to improve intraseasonal to interannual (ISI) predictions^{13, 14}. The NMME has been a research effort led by the NOAA MAPP Program as part of NOAA's Climate Test Bed activities and has been supported by a partnership of USGCRP¹⁵ agencies (DOE, NSF, NASA). Over two years of real-time predictions and thirty years of hindcasts are available from the NMME-Phase 1 system; data from an upgraded NMME-Phase 2 system are becoming available online¹⁶. Aside from including an upgraded set of models, the NMME-Phase 2 system will also include data at higher temporal resolution (daily and 6 hourly for selected variables) compared to the monthly NMME-Phase 1 system data.

Initial evaluations of the NMME system have indicated improvements in skill for basic aspects of ISI predictions compared to predictions from any given individual system. In order to exploit the full potential of the NMME-Phase 2 system and understand future development steps, it is necessary to more extensively evaluate NMME predictions considering the full spectrum of predicted variables. Additionally, it is also important to explore potential new applications of the NMME system to predictions.

To this end, in FY 2015, the MAPP Program jointly with the DOE Regional and Global Climate Modeling Program (RGCM) and the Navy Office of Naval Research (ONR) solicits proposals in the following two research areas:

- A. Evaluation of NMME system predictions
- B. Exploration of new applications of NMME system predictions

Within this competition, proposed research may be relevant to one or both of the research areas above. Primary focus of proposed projects will be data from the NMME-Phase 2 system.

Area A. *Evaluation of NMME system predictions*

Proposed NMME evaluations will examine the skill of NMME system predictions focusing on less-well documented, yet potentially important aspects of the predictions. Research will help to document the representation of climate phenomena underpinning known intraseasonal to interannual predictability sources and examine the linkages between those sources and prediction skill or lack thereof in the system. Of particular interest are those studies evaluating the prediction of large-scale, extended lead time conditions conducive to extremes such as heat waves, extreme precipitation (rain, snow or ice storms) or droughts provided a theoretical basis for expecting predictability on ISI timescales exists.

Area B: *Exploration of new applications of NMME system predictions*

Washington, DC. National Academy Press. http://www.nap.edu/catalog.php?record_id=12878

¹² NMME is also known as the National Multi-Model Ensemble.

¹³ <http://www.cpc.ncep.noaa.gov/products/NMME/>

¹⁴ Kirtman et al., 2014: The North American Multi-Model Ensemble (NMME): Phase-1 Seasonal to Interannual Prediction, Phase-2 Toward Developing Intra-Seasonal Prediction. Bulletin of the American Meteorological Society 2013 ; e-View doi: <http://dx.doi.org/10.1175/BAMS-D-12-00050.1>

¹⁵ <http://www.globalchange.gov/>

¹⁶ http://www.cpc.ncep.noaa.gov/products/ctb/nmme/NMME_Phase2_data_description.pdf

Application of the NMME for the development of new prediction products may be proposed as part of exploratory pilot studies. Projects should build on existing NMME forecast variables and may include the offline prediction of secondary physical quantities of interest to various sectors. Proposed applications should build on those aspects of the NMME predictions for which a theoretical basis for expecting predictability exists and significant prediction skill can be expected based on previous evaluations. Proposed pilot applications should be at a continental scale, although they may have particular regional applicability (e.g. Arctic sea-ice predictions). Proposals for the development of regional or local prediction systems are outside the scope of this solicitation. Note that the development of applications of the NMME predictions for stakeholder planning, adaptation or mitigation activities are not supported through this solicitation.

All proposals must include statistically robust evaluations based on available verification data and standard evaluation metrics¹⁷. One year projects up to \$70K are being sought by this solicitation. Proposals will be supported by a partnership between the MAPP program, the DOE RGCM Program, and ONR; successful proposers may be asked to also submit their applications to partner agency programs for funding. Selected investigators are expected to contribute to Climate Prediction Task Force activities¹⁸.

Competition Contact Information:

MAPP Program Manager and Competition Manager: Dan Barrie (daniel.barrie@noaa.gov)

RGCM Program Manager: Renu Joseph (renu.joseph@science.doe.gov)

ONR Program Manager: Dan Eleuterio (daniel.eleuterio@navy.mil)

Competition: Advancing a common software modeling infrastructure for NOAA's global models

To enable distributed, open, and rapid model development and evaluation, modern software engineering methodologies must be able to meet the growing complexity of models and volume of model output data. One of the primary recommendations of the NRC Report "A national strategy for advancing climate modeling"¹⁹ is to advance the development of a common software infrastructure for climate modeling. A pioneering and foundational effort for the advancement of such a software infrastructure is the Earth System Modeling Framework (ESMF) supported by several US agencies and adopted by a number of leading modeling centers. The framework is used in the development of several NOAA weather and climate models²⁰. Research is needed to evolve the software modeling infrastructure to meet new model development needs. The application of an efficient and common software modeling infrastructure for NOAA models is key to facilitating interoperability of model components across NOAA weather, climate, and Earth system models, and with those of other leading National models. For example, the National Centers for Environmental Prediction (NCEP) has developed the NOAA Environmental Modeling System (NEMS)²¹ which is a common modeling framework with architecture based on the ESMF. The effective management, dissemination, and analysis of model data and metadata through a common software infrastructure are needed for the advancement of climate and Earth

¹⁷ Metrics and assessment protocols defined by NCEP are listed here:

http://www.cpc.ncep.noaa.gov/products/ctb/meetings/2013/Metrics_climate_models&fcst_26July.pdf

¹⁸ The MAPP Climate Prediction Task Force:

<http://cpo.noaa.gov/ClimatePrograms/ModelingAnalysisPredictionsandProjections/MAPPTaskForces/ClimatePredictionTaskForce.aspx>

¹⁹ National Research Council, 2012. A National Strategy for Advancing Climate Modeling. Washington, DC. National Academy Press. http://www.nap.edu/catalog.php?record_id=13430

²⁰ <http://www.earthsystemmodeling.org/>

²¹ http://nomads.ncep.noaa.gov/txt_descriptions/NEMS_NMM_doc.shtml

system models and their applications. Such a software infrastructure is maintained and developed by the Earth System Grid Federation²² (ESGF), the backbone of international model data distribution for CMIP5.

Given the importance of advancing a common modeling software infrastructure for climate and Earth system models, in FY 2015, the MAPP program solicits a team proposal with the following objectives:

1. Advancing ESMF to provide new capabilities that can optimize interoperability, future development and performance of NOAA global models;
2. Development of new applications for using existing ESMF capabilities in NOAA models and their atmospheric, oceanic, and land sub-components, and effective coupling, as well as other interoperability efforts including the porting and testing of new components;
3. Development of new software engineering approaches to maximize computational efficiency and model documentation facilitating broad community model development and usability;
4. Development of software data infrastructure enhancing ESGF capabilities as required by NOAA laboratories and modeling centers for effective use of NOAA model data by the broader community;

Proposals should aim to advance NOAA operational center and research laboratory software infrastructure for climate and Earth system models toward a common community framework that builds on past efforts. Proposals should demonstrate engagement of NOAA modeling centers in the design and application of the software infrastructure enhancements, and relevance to their development plans. A successful proposal should include a feasible workplan including roles and responsibilities of the investigators as well as main tasks, milestones and deliverables within the scope of the project.

Proposals may be for up to 3 years and up to \$1M per year. One award may be made as a result of this competition in the form of a Cooperative Agreement.

Competition Contact Information:

MAPP Program Manager Competition Manager: Annarita Mariotti (annarita.mariotti@noaa.gov)

General Guidelines for FY 2015 MAPP proposal submission for all competitions

- Principal Investigators submitting a proposal in response to this MAPP Announcement are required to follow the Letters of Intent and Proposal preparation and submission guidelines described in the Climate Program Office FY 2015 Federal Funding Opportunity announcement.
- Investigators are strongly encouraged to submit Letters of Intent prior to developing and submitting a full proposal. MAPP program Letters of Intent should be emailed to oar.cpo.mapp@noaa.gov.
- Proposals must clearly identify in their summary which one of the above-listed MAPP competitions is being targeted (only one competition may be targeted by a given proposal) and which sub-element of the competition is being targeted, if applicable.
- Administrative questions regarding the Federal Funding Opportunity (e.g. proposal formatting or submission guidelines) should be directed to Diane Brown (diane.brown@noaa.gov).

Computational resources on NOAA's high-performance computing platforms are available for research sponsored as a result of this solicitation. Proposers who choose to request computational allocations on NOAA's platforms must include in their proposal a request describing the computational resources and data storage required, as well as a description of how they will port their methodology to the NOAA platforms.

²² <http://esgf.org/>

Proposers must submit a request form for computational resources²³. Questions regarding the use of NOAA's high-performance computing platforms should be directed to Dan Barrie (daniel.barrie@noaa.gov).

²³ http://cpo.noaa.gov/sites/word/Documents/word/MAPP_FY15_HPC_Request_Form.docx